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EXAMINATION OF PURPOSES OF WATER PRICING

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EXAMINATION OF PURPOSES FOR WATER PRICING

By

Allen LeBaron

Presented at the "1983 Irrigation Water Protection Function
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Topic VII: Approaches to Water Pricing

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EXAMINATION OF PURPOSES FOR WATER PRICING

Introduction

These lectures will not deal with Riparian situations. We assume some "rights" to water that precludes bidding or auctioning of use rights each year. What is at stake is not the use of water itself; we are also interested in the facilities necessary to store and convey it to where it is needed. How farmers utilize water might be expected to depend merely on whether they pay anything for it. The timing of when payments are calculated may not be very influential.

1. There will always be some revenue collected in some form, because there is a continuing need to pay operating and maintenance charges.
 - a. Sometimes these payments are in kind and not in cash.
 - b. Fulfilling this need does not have to involve the State.
2. The only other reasons for collections by-the-State ^{are} is to: obtain general revenues, recover costs of facilities, regulate use of resources, ^{in general} and regulate use of a water resource that has ^{been} been privately appropriated.
3. The above reasons are all interconnected.
 - a. Collections for general revenue purposes may or may not influence

planning, construction, efficient use, and cost recovery of new facilities. As far as long-run resource allocation is concerned, collections made to recover cost of facilities may or may not add to general revenues.

- b. Collections, for general *revenue*, will always affect rate of use of resources in the short run. This is because the price acts as a tax, and this tends to cutback usage. If the levy is made at the start of the irrigation season, the amount of revenue collected will be a function of the slope of the demand curve for water (not precisely accurate) at the start of the season. Water demand from storage or in river flows will be cutback by such charges. However, the individual water units actually taken during the season will be treated as though they are free and that the cost of purchasing them have already been incurred. If the levy is made on units of water delivered throughout the season, there may be some cutback on use in certain parts of the season. Collections will always add to the general revenue.

A water tax might generate considerable revenue and create some water "savings" that can be used to supply other farmers--probable

supplies can be switched around--but have small effect on actual usage during a season, since the cost by that time will be treated as sunk. If the tax is high enough, water demanders will cut themselves back to where expected deliveries will be equal to or less than expected consumptive use by the crops. Users may switch to sprinklers (divert less water) or they may agree to pay the tax while bringing more land in under a different mode of irrigation.

c. Revenue collections could be justified for the same reasons that land taxes are justified--certain persons in society are in control of certain production assets that are important to everybody. Property has often been taxed, and some form of rights to water availability could be treated as property. Similarly, if land is rented from the State water could be, too. Water taxes might not be too hard to collect, because user groups are often involved and may operate as the collection agent.

d. Collections could be made to recover costs of facilities. Paying for any investment always causes some confusion. The first consideration is the time period before any resources are committed to the investment. During this period, risk and potential payoffs

are assumed, and benefit/cost ratios are calculated based upon expected selling prices of the proposed production. In the private sector, if all goes well, the investors will meet expenses, recover capital with interest, and earn additional profit--if lucky. In this case, they may roll their capital over into another round of investment. If they are unlucky, they lose capital or bankrupt and are driven out of the industry. In other words, they cover their capital costs until all their invested capital wears out.

As we have seen earlier, many issues are involved when public sources are to be committed: What are the arguments for the investment? How did a particular irrigation design get proposed in the first place? Is it adequate? What is to be the role of subsidy? Society can define efficiency anyway it pleases--and if it chooses to provide a lot of subsidy by not charging for facilities, there is nothing immoral about that decision other than failure to recognize that someone, somewhere will have to bear the cost of subsidy.

Once a decision has been made to recover costs of facilities, a certain type of reasoning applies: the schedule of charges to be levied may be expected to cover full costs to society or recover those costs

society says must be recovered. Let us see how recovery is viewed in private firm (add in the differences made by monopolies).

Sunk-Costs--and-Private-Control-in-Public-Sector

Once a facility has been built we move into the time period after the resources have been committed and into the period of sunk costs. As we have seen in the private case, if planned demand does not materialize, the firm does the best it can to cover variable costs and recover any portion of fixed costs possible. The firm does this by accepting any prices above average variable cost and produces where price = marginal cost or, if it can control price, it cutsback until the new marginal revenue = marginal cost are all covered (as in monopoly).

1. A public entity with lack of demand cannot do quite the same thing.

While it tends to have monopoly (price setting) power, it would prefer output to be as though there were competition. This would put output where price = marginal cost. This is due to the relationship between sunk costs and society's opportunity cost. If society's sunk costs cannot be recovered, the best use of resources is to cover variable costs as well as possible. In some extreme cases, the variable costs are very low or nil--the use of a bridge or railroad tunnel might not

cost society anything once the resources are committed. If the opportunity cost to society is low or zero, prices should be the same in order to encourage use. This is the philisophical foundation for marginal-cost pricing.

2. If the free use of the facility is so great that it becomes congested, individual begin to rise, but it can be shown that the marginal social costs rise even faster, and that efficient use of the facility requires a toll to be levied on use equal to the difference between marginal and average social costs.

The conveyance facilities of our irrigation systems are somewhat like a footbridge or a railroad tunnel; there is a maximum amount that can flow, given the pipe or cannal dimensions and the water level.*

In some cases storage may seem excessive, even to protect against drouth, and observers may think that prices should be lowered in order to utilize more water. However, the governing criteria is how much mwater can be put through the smallest part of the system--where the maximum value is achieved, prices are low enough. Further lowering will not encourage more

*Where individual decisions are controlling "flow," the congestion can become so great as to cause total stoppage.

throughput even if actual marginal costs (opportunity costs) are lower. By the same token, there is no automatic guarantee that raising prices will cut the flow, at least up to some point. Generally, this maximum throughput will be achieved very quickly as the project stages up to full-land and water utilization. Thus, the most general rule is that manipulation of "water prices" cannot affect the efficiency of conveyance facility use since the facility runs at capacity and the farmers are not on a demand system. When there is space in the system, it is because water is being deliberately held back--(dam) or the stream source has fallen in volume.

Demand-System-Exception

A demand system is analagous to purchasing electricity--the users only purchase varying amounts when and if they choose. In the U.S.A., the water utilized for home consumption is on demand systems. Two features are involved: 1) the usage is metered and 2) demand tends to come in peaks; thus, capacity (storage and delivery) must be adequate to service the peak loads--at all other times the system has underutilized capacity.

The classic efficiency problem and its solution, when users must finance such a system, is well known. The problem is to entice users to switch use to nonpeak periods. This is solved by marginal-cost pricing, in

other words, lowering tariffs to encourage utilization. However, marginal-cost pricing does not cover capital costs under such circumstances; equipment wears out, and there is no real division for depreciation or interest return on invested capital. To solve this last problem, a lump-sum payment is required of users who join the system. This payment can take the form of a meter charge, a "hook-up" fee, etc.

The resulting structure composed of a lump sum to cover important capital costs, plus a sliding fee related to marginal costs of measured use at certain periods, is called a two-part tariff. [Note that it is underutilized capacity that creates a situation where additional use can be obtained at low or zero social opportunity cost.]

Obviously, the typical irrigation system is not a demand system--a demand system may be a necessity in electrical, natural gas, or other public utility delivery services, but it is a luxury in irrigation.

New-Construction-Effects-Modifications

A road that requires tolls to reduce congestion will earn rents that in the private world are the "green light" to further development. Once

*The definition of economic efficiency is that as long as social opportunity costs are below what people are willing to pay--output should be expanded by lowering price.

the rents are being obtained and interpreted as effective demand for additional road space, a peculiar thing happens. Currently, the toll is too high to control flow. Next, a new road is built parallel to the old. Two roads are now available to handle the demand. Congestion falls off; there is no need, on efficiency grounds, to set such high toll. In fact, a high toll does not generate any revenue since people switch back to the low cost original road which is now uncongested. The new low, or no toll, for the two roads, set according to the social opportunity cost of average travel, will not generate enough money to pay for the new road. There is surplus capacity, and, again, the way out is a two-part tariff.*

In the case of a full cannal, as we have seen, the flow is as full as the source will permit. There is no necessary connection between revenues charged and effective demand; revenues may or may not be interpreted as indicators of need for further development. Further development may be impossible due to the size or availability of the source. If a parallel facility is technically feasible and runs at capacity, recovery of costs can be attempted in whatever way seems most reasonable and equitable.* If

*The capital charges might be levied once per year upon drivers who habitually utilize the roads during peak or congested hours.

the facility has genuine excess capacity, a two-part tariff might work to encourage more use of the facilities.

1. Efficiency of use at farm level cannot use charges to make facility efficiency go up. The question now is, whether charges can make the on-farm level efficiency of use rise? This is like asking whether the final consumers' consumption of electricity is wasteful. In this case, we argue that they can use what they paid for as they please. Where farmers are concerned, we cannot say that, because we want to increase output and to use delivered water as well as possible. Here we run into a potential contradiction, in that, to obtain efficient conveyance-system usage we lower prices to social opportunity cost levels in order to curb waste on the farm. We want higher , and, yet, we want higher unit prices!* Luckily, as we have seen, fiddling with prices won't affect system use efficiency; so, all we are left with is on-farm water use efficiency.

* However, the congested road is only possible because the "source" of the flow can be made larger or smaller by individual decisions of whether or not to travel from A to B. A water source is a constant (except for low flow times) on a river system and the road (pipe) is sized to handle its invariable output. This is one way the road or tunnel analogy breaks down.

Efficient use is technically defined according to consumptive use requirements of crops.

Crops can only utilize so much water. If the amount available is "adequate" or "over-adequate," any excess percolates to underground aquifers or returns to some river system where other irrigators can use it. If more "efficient" irrigation is practiced, for whatever reason, this means less water is diverted and residual used elsewhere (more rapidly than when waiting for it to appear via overland return) or more land is irrigated with the same amount of water and reduction of overland return and irrigated land elsewhere. Raising water prices might have an effect on this type of "efficiency," (where the potential gains are measured by the production, if any, foregone if water is "wastefully" applied in one area, and, for some reasons, the overland return is not used elsewhere.

Excepting such special cases, the collection of increased charges may help finance an on-going project, or even raise general revenue, but the

*When American public utilities and government leaders called for American to "conserve" energy usage, the natural excess capacity of the energy delivery systems was effectively increased. Revenues fell and the companies asked for rate increases to cover capital costs. As a result, individual attained a reduced amount of electricity or natural gas for the same or more money. Not all the cutbacks were a response to higher prices; of course, a cycle of raising prices and cutting consumption is self-reinforcing.

collective will have little or no meaning in terms of increasing net production. It might be supposed that designed capacities are not adequate to satisfy consumptive use requirements. This is a common situation. Farmers do not have enough water and must decide whether to short all crops or leave some land unplanted in order to concentrate more water to less space. This decision automatically forces farmers to make an efficiency of water-use decision. In a water-short situation, a system of water charges will not effect efficiency of use one way or another. There is no "waste" to control. If a system of charges is overlaid on top of inadequate supplies the goal can only be to tax for general revenue. Payments will be resisted or will have to be set at levels commensurate with profitability situation of the farmers. At the same time, it must be realized that any level of charge that actually reduces levels of use below what would be justified by society's opportunity cost is too high.

This reinforces the general observation that fees to collect revenue and the efficiency goal of benefiting from sunk costs where society's operating costs are low may be mutually exclusive. What project planners may fail to account for is that a "well designed" surface project will throw-off water which will be used elsewhere, outside the project, as

suppliment or for new land. The only way this won't occur is if the project is designed for sprinklers in the first place. Then efficiency of use would not be an issue. Planners should view on farm efficiency in drainage wide terms--not limited to the specific project of their responsibilities. If project planners feel project farmers are wasteful and cause farmers to be more "efficient", either more land will be opened up in the project (closing down land outside) or lower diversions will move more water quickly to downstream users.

Fees can be set to cover project costs or obtain revenues in a manner appropriate to the situation. The charges, if general, will create the general impact of any tax, cut production, and raise prices to a greater or lesser degree. Specific charges levied on particular projects beneficiaries can be levied on a lump-sum basis by setting contracts with annaul payments. In some cases, account is taken of the cubic meters delivered and a charge/unit is collected. As mentioned earlier, these charges may affect marginal costs, and, therefore, cutback individual consumption (the residual will be used elsewhere and may or may not be subject to the special fees to recover project costs).

In summary, the general situation is that fiddling prices will not effect efficiency of conveyance facility; the process will not affect global drainage production at the farm level if water supplies are adequate, and, if they are adequate, scarcity will create its own efficiency.

Efficiency-in-Use-of-Private-Facilities

The previous few paragraphs generally apply to irrigation in the private sector.

Such facilities may or may not represent capital investments that must be repaid in order to prevent financial losses. More likely, the facilities are quite old and their use imposes no social cost of an appreciable nature on society, and their owners have had "good" use of them. Thus, from either a private or public standpoint, the more the facilities are used the better.

Obviously, it is possible, in some cases, that more water is diverted and applied to crops than consumptive use requires. Again, whether this represents wasteful use depends upon the hydrology of the total system and what use is made of return flows by other irrigators. As we have seen, a system of charges may alter technology and bring in more land or cutback

diversions in a certain area. Depending on the entire irrigation pattern of a drainage, either response will trigger downstream impact observed as less land irrigated. The same amount or slight expansion of land all depended upon how much water actually reaches them and how they in term react to the tax.

The more general situation is that existing water systems do not divert "excess" water, they tend to stretch all the water they can get and users feel that they need additional water. The user group is constrained by shortage to do the best it can. Again, efficiency of water use is guaranteed by physical shortage. Fees simply raise revenue. New techniques will be introduced if the crops are valuable and if the water begins to cost some money.

Water charges may be levied as public leaders see fit, but the reasons for such levies would mostly turn on desires to collect general revenue since neither efficiency nor system cost recovery is at stake. Reasoning based upon arguments of achieving greater efficiency in resource use, as we have seen, are unlikely to be valid except in special situations where the downstream hydrology is such as to prevent reuse or there are no downstream users, etc. The irony of these special situations is that it makes no

difference if water is "wasted" or not; if there is no further use who cares? The hydrologic cycle will replace it next year or some "excess" might be held in storage if the system includes the requisite facilities.

Water-use efficiency in private systems based on individual pumping from underground or river sources is controlled by pumping costs vs. the consumptive needs of the crop. The only way too much water will be used is if pumping costs are very low and water is "substituted" for other inputs (when in doubt use more water) or if a mistake is made in judging the amount and timing of water needed by the crops.

1. The pricing structure probably must be controlled by any decisions to recover some system costs. The pricing situation probably will not affect system efficiency and probably will not affect on farm efficiency basin-wide systems although it might affect water use on a given project.

- a. Efficiency in facility use may or may not be harmonious with consumptive needs of crops. Marginal cost pricing of facility users would move more water through the system. Farmers might treat water as the cheapest input (and create a lot of overland return). No general effect on basin-wide efficiency.

2. Whether pricing can effect efficient use of facility depends on whether or not they run at capacity.
3. Wheter pricing can affect overall efficent use at the farm level depends on particular and possibly unimportnat situations, i.e., no reuse (if no reuse, who cares). As long as water is reused, it is stretched to achieve efficiency. If it cannot be reused, due to under supply, what ever is possible at any point in the system is achieved all down the line.
4. Water charges may simply be asorbed if supplies are tight. If alternative in crops and are available, the charge may force a search for higher yield through changed technique. Otherwise charges simply shift use somewhere else. If they are high enough, even in a "adequate" surface system technique may change, and this will be in use shifts.

If less is diverted, downstream users may actually have more water, since lower upstream run-off may mean less perculates into the aguifer.

5. Recovery of the construction costs of large public works costs are often thought to be unharmonious with their effective utilization, once

costs are sunk. However, in the irrigation case, costs allocated to farmers for collection may be collected in many cases without regard for efficiency impacts upon the conveyance system or at the farm level.

We have talked about efficiency in water use or management. Thus far, we have concentrated on efficiency in utilization of the conveyance system and at the farm level. Other concepts of the efficiency are certainly involved, such as, the overall engineering concepts or possibly the physical management of the storage facilities or coordination with hydropower generation. In addition, there is also the notion of being able to shift and move water between systems and over large areas according to changing agricultural needs or possibly other nonagricultural needs.

In the Western U.S.A., this question has received considerable attention, because economic development has tended to reduce the need for agricultural water and increase the demand for municipal and individual supplies. This alteration in the structure of water demand would not create any problems except for the fact that the flows or availabilities of most water sources have been appropriated by public or private entities.

Thus, in order to satisfy a new demand, there must be a redefinition of the terms of existing water rights or the rights must be transferable.*

But transfers must be approved because shifting diversion points have impacts on other users and potential conflicts must be resolved. Thus, "rights" do not trade at will in the market. In earlier times, of course, the appropriation doctrine might have been looked upon as a deliberate method to remove a vital resource from the normal workings of the market in the name of equity.

Nowadays, the idea is that people or institutions who need water will look towards agriculture for a low cost supply that can be transferred to uses upon which society places higher values. The system that restricts transfer unduely is, therefore, inefficient.*

Head-End/Tail-End--Extension

One of the most difficult real-world problems in irrigation water utilization is encountered in many "unstructured" situations; users at the

*There is some scope for appropriating additional water if winter run-off can be utilized. Control of winter run-off, so it can be utilized all year, requires adequate and costly storage.

*In societies that do not grant "rights" they can move water at will--on paper. In practice, they have to be careful. In practice, they have all the problems of balancing water uses, quantity, and quality concerns that the U.S.A. has. They are forced to set rules by which command decisions can be made. Some rules may be codified in water law.

head of the ditch get more water than those at the end. A common observation is that the farmers have ample or "excess" water, the latter do not have enough. In other situations this never happens, because, one way or another, controls are imposed to prevent such practice.

What role can imposition of fees play in exercising such control?

To control water use at the head of a ditch with a lump-sum payment would require special charges on head and users. The result would be two types of payments or water-fee collections among the same user groups. In addition, as we have seen, a lump-sum tax, at say the start of each irrigation season, would be treated by the farmers as a fixed cost of annual production. Once paid, it would not effect the level of use during the season. A strong physical monitoring system would be required during all irrigation periods. If fees are imposed on the basis of units of water delivered, those who use the most will pay the most, and the effect should be to cause water used to be cutback. Thus, more water will stay in the ditch for other users.*

Again, the unit measurement must be checked on or enforced and fees collected. These must be on the basis of human supervision. That being the case, equity in water use anywhere in the system can be controlled

directly by inspection of "ditch riders"; no fees are necessary to solve the head-end/tail-end problem. In fact equity will only be served by recognition of the controls necessary to live in a collective. The prime purpose for fees could be concentrated upon repayment of system construction costs or for other purposes.

Extra heavy water use at the head-end of a ditch cannot be solved by charging for water. Unless, the actual water entering the farm headgate can be measured and recorded.* Otherwise, human monitoring and control is required.

*Water meters are designed into the planned on-farm sprinkler development in the Majes Project, Peru.